Notice of Allowability	Application No.	Applicant(s)	
	10/598,695	UDAGAWA ET AL.	
	Examiner	Art Unit	
	Jean B. Corrielus	2611	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *6/4/09*.
2. ☒ The allowed claim(s) is/are *1-4*.
3. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☒ All b) ☐ Some* c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☒ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 12/14/06
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☒ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

/Jean B Corrielus/
Primary Examiner, Art Unit 2611

DETAILED ACTION

EXAMINER'S AMENDMENT

1. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Steven Wegman on 6/23/09.

The application has been amended as follows:

IN THE DRAWINGS:

The drawings have been amended per the attached replacement sheets.

IN THE ABSTRACT:

The abstract has been amended as shown in the last page of this examiner's amendment..

IN THE SPECIFICATION :

The specification has been amended as follow:

--[0012] In order to solve the above problems, one aspect of the transmission apparatus of the present invention employs a configuration of a transmission apparatus using a polar modulation scheme, and this transmission apparatus has: an amplitude phase separation section that separates baseband modulation data into a baseband amplitude modulation signal and a baseband phase

modulation signal; a phase modulation section that modulates a high frequency carrier signal based on the baseband phase modulation signal and forms a high frequency phase modulation signal; a variable gain ~~amplification section~~ amplifier that is provided in a later stage of the phase modulation section and amplifies the high frequency phase modulation signal; and a high frequency power amplifier that is provided in a later stage of the variable gain ~~amplification section~~ amplifier and amplifies power of the high frequency phase modulation signal amplified by the variable gain ~~amplification section~~ amplifier, wherein the variable gain ~~amplification section~~ amplifier has a linear-log conversion circuit that linear-log converts the baseband amplitude modulation signal, and ~~a variable gain~~ an amplifier that amplifies the high frequency phase modulation signal based on the linear-log converted baseband modulation signal and a gain control signal.

[0013] According to this configuration, since the variable gain ~~amplification section~~ amplifier is provided, as compared with the case where all amplification processing of the high frequency phase modulation signal is performed by the high frequency power amplifier, it is possible to perform amplification processing taking into account performance of the high frequency power amplifier and obtain transmission output power with wide dynamic range by combining amplification processing of the high frequency power amplifier and the variable gain ~~amplification section~~ amplifier. That is, by controlling a gain of the variable gain ~~amplification section~~ amplifier and thereby controlling the level of the high frequency phase modulation signal inputted by the high frequency power amplifier, it is possible to reduce the leakage power. As a

result, with the high frequency power amplifier, it is possible to extend the output power control range by the supply voltage.

[0014] In addition, the variable gain ~~amplification section~~ amplifier has a linear-log conversion circuit that linear-log converts a baseband amplitude modulation signal and ~~a variable gain~~ an amplifier that amplifies a high frequency phase modulation signal based on the linear-log converted baseband amplitude modulation signal and a gain control signal so that the ~~variable gain~~ amplifier can perform both average signal level control by the gain control signal and instantaneous amplitude control based on the baseband amplitude modulation signal on the high frequency phase modulation signal, and it is possible to simplify the configuration on a signal line for amplifying the high frequency phase modulation signal. With a simple configuration in which, for example, a plurality of stages of ~~variable gain~~ amplifiers are provided or the same ~~variable gain~~ amplifier is shared, it is possible to apply both average signal level control based on the gain control signal and instantaneous amplitude fluctuation control based on the baseband amplitude modulation signal to the high frequency phase modulation signal.

[0015] Another aspect of the transmission apparatus of the present invention adopts a configuration wherein the variable gain ~~amplification section~~ amplifier further has an adder circuit that adds the baseband amplitude modulation signal linear-log converted by the linear-log conversion circuit and the gain control signal, and the ~~variable gain~~ amplifier amplifies the high frequency phase modulation signal based on the signal added by the adder circuit.:

[0016] According to this configuration, since average signal level control and instantaneous amplitude control can be performed by the same ~~variable gain~~ amplifier, it is possible to correspondingly reduce the number of stages of ~~variable gain~~ amplifiers and thereby reduce the circuit scale.

[0018] According to this configuration, in the first operation mode (for example, in the case of obtaining high level transmission output power), by operating the high frequency power amplifier as a nonlinear amplifier, it is possible to significantly improve power efficiency. Furthermore, in the second operation mode (for example, in the case of obtaining low level transmission output power), the high frequency power amplifier is made to operate as a linear amplifier, and amplitude control by the baseband amplitude modulation signal and the gain control signal is performed at the variable gain ~~amplification section~~ amplifier. As a result, it is possible to maintain high power efficiency of the high frequency power amplifier and well perform average signal level control by the gain control signal and instantaneous amplitude control by the baseband modulation signal on the high frequency phase modulation signal over a wide range.

[0028] On the other hand, baseband phase modulation signal S3 is first inputted to frequency synthesizer 106. Frequency synthesizer 106 obtains high frequency phase modulation signal S4 by phase modulating carrier frequency at baseband phase modulation signal S3 and transmits this signal to variable gain ~~amplification section~~ amplifier 201.

[0029] Variable gain ~~amplification section~~ amplifier 201 has two ~~variable gain~~ amplifiers 202 and 203, linear-log conversion section 206, digital-analog conversion circuits (D/A) 204 and 207, and low-pass filters (LPF) 205 and 208.

[0030] Variable gain ~~amplification section~~ amplifier 201 inputs baseband amplitude modulation signal S2 outputted from switch 111 to linear-log conversion section 206. Linear-log conversion section 206 log-converts baseband amplitude modulation signal S2 and outputs the result. The manner of this linear-log conversion is not described in detail, but can be readily implemented by a known digital signal processing circuit. The log converted baseband amplitude modulation signal is inputted to ~~variable gain~~ amplifier 203 as a gain control signal of ~~variable gain~~ amplifier 203 via digital-analog conversion circuit (D/A) 207 and low-pass filter (LPF) 208.

[0031] Furthermore, variable gain ~~amplification section~~ amplifier 201 provides gain control signal S21 to ~~variable gain~~ amplifier 202 as a gain control signal of ~~variable gain~~ amplifier 202 via digital-analog conversion circuit (D/A) 204 and low-pass filter (LPF) 205.

[0032] Gain control signal S21 is a signal in which an offset corresponding to gain offset signal S20 is added to gain control signal S12 by adder 110. This gain offset signal S20 is set to ~~variable gain~~ amplifier 202 so that a signal of the level suitable for making high frequency power amplifier 105 operate as a nonlinear amplifier in saturation operation or switching operation area, can be obtained. ~~Variable gain amplifier~~ Amplifier 202 amplifies high frequency phase

modulation signal S4 according to gain control signal S21 and transmits the amplified signal to ~~variable gain~~ amplifier 203.

[0033] Either baseband amplitude modulation signal S2 or baseband amplitude modulation signal S2 in which a lower limit value is limited by lower limit value limitation circuit 112, is inputted to linear-log conversion section 206 via switch 111. In addition, lower limit value limitation circuit 112 limits a lower limit value for amplitude fluctuation of baseband amplitude modulation signal S2. By this means, ~~variable gain~~ amplifier 203 performs amplitude modulation on the output signal of ~~variable gain~~ amplifier 202 based on either baseband amplitude modulation signal S2 in which a lower limit value is limited or baseband amplitude modulation signal S2 in which a lower limit value is not limited, and transmits the result to high frequency power amplifier 105.

[0034] High frequency power amplifier 105 amplifies the high frequency phase modulation signal outputted from variable gain ~~amplification section~~ amplifier 201 using the supply voltage value supplied from amplitude modulation signal amplifier 104 and obtains transmission output signal S30.

[0040] On the other hand, as for high frequency phase modulation signal S4, when the level of transmission output signal S30 is relatively large, terminal a and terminal c of switch 111 are connected by mode switching signal S10. As a result, a signal in which the amplitude fluctuation lower limit value of baseband amplitude modulation signal S2 is limited by lower limit value

limitation circuit 112, is inputted to linear-log conversion section 206 of variable gain ~~amplification section~~ amplifier 201 via switch 111. By this means, the output signal of ~~variable gain~~ amplifier 202 is amplitude modulated at ~~variable gain~~ amplifier 203 based on baseband amplitude modulation signal S2 in which a lower limit value is limited, and transmitted to high frequency power amplifier 105.

[0041] Here, generally, voltage gain V_{out}/V_{IN} between input and output of a variable gain amplifier is an exponential function of a gain control signal. Taking this into consideration, in this embodiment, by log converting baseband amplitude modulation signal S2 at linear-log conversion section 206 and supplying the result as a gain control signal of ~~variable gain~~ amplifier 203, ~~variable gain~~ amplifier 203 is adapted to implement linear operation for baseband amplitude modulation signal S2. In other words, by providing linear-log conversion section 206, it is possible to implement multiplication of high frequency phase modulation signal S4 and baseband amplitude modulation signal S2 using ~~variable gain~~ amplifier 203.:

[0042] In this way, by performing multiplication by ~~variable gain~~ amplifier 203 with baseband amplitude modulation signal S2 as a gain, it is possible to perform average signal level control by gain control signal S12 and instantaneous amplitude control by baseband amplitude modulation signal S2 using a variable gain amplifier of the same configuration. By this means, amplifiers can be readily manufactured.

[0043] Furthermore, the variable gain ~~amplification section~~ amplifier of the present invention, actually, is not simply divided into two blocks as shown in FIG.2, and, for example, two out of three dependently connected variable gain amplifiers are used as ~~variable gain~~ amplifier 202 for controlling the average signal level, and the other one is used as ~~variable gain~~ amplifier 203 for performing instantaneous amplitude control. In this case, as described in this embodiment, if average signal level control and instantaneous amplitude control can be performed on the similar variable gain amplifier, it is possible to readily change the number of variable gain amplifiers assigned for each control according to specifications. This increases the versatility and improves the usability.

[0050] In this embodiment, linear-log conversion section 206 performs log conversion, and then ~~variable gain~~ amplifier 203 multiplies an exponent. Therefore, the output becomes linear as a result. When an inverse function of equation (5) is applied to the linear-log conversion performed at linear-log conversion section 206, ~~variable gain~~ amplifier 203 can perform accurate linear amplification. Furthermore, when input is small enough, if an inverse function of the approximation of equation (8) is applied to the linear-log conversion performed at linear-log conversion section 206, there is practically no problem.

[0053] In this way, according to this embodiment, by providing linear-log conversion section 206 and ~~variable gain~~ amplifier 203, log-converting baseband amplitude modulation signal S2 and setting the log-converted signal as a gain control signal of ~~variable gain~~ amplifier 203, it is possible to provide instantaneous amplitude fluctuation by baseband amplitude modulation

signal S2 at ~~variable gain~~ amplifier 203. As a result, both average signal level control by gain control signal S12 and instantaneous amplitude fluctuation control by baseband amplitude modulation signal S2 can be performed on high frequency phase modulation signal S4 at a variable gain amplifier so that it is possible to simplify the configuration on a signal line for amplifying high frequency phase modulation signal S4, and also increase the versatility and improve the usability.

[0054] Furthermore, since the linear-log converted value is digital-analog converted and provided to ~~variable gain~~ amplifier 203, compared to the case of digital-analog converting an antilogarithm, the number of bits required at D/A 207 is reduced. As a result, it is possible to simplify the configuration of D/A 207 and reduce the processing time.

[0055] Still further, in this embodiment, variable gain ~~amplification section~~ amplifier 201 is provided in the anterior stage of high frequency power amplifier 105. In the first operation mode, a supply voltage changed according to baseband amplitude modulation signal S2 and gain control signal S12 is supplied to high frequency power amplifier 105 so that high frequency power amplifier 105 operates as a nonlinear amplifier, and thereby amplitude modulation according to baseband amplitude modulation signal S2 and gain control signal S12 is performed by high frequency power amplifier 105. In the second operation mode, a fixed supply voltage is supplied to high frequency power amplifier 105 so that high frequency power amplifier 105 operates as a linear amplifier, and thereby amplitude modulation according to baseband amplitude modulation signal S2 and gain control signal S12 is performed by variable gain

amplification section 201. It is thereby possible to maintain high power efficiency of high frequency power amplifier 105 and implement efficient average signal level control by gain control signal S12 and efficient instantaneous amplitude control by baseband amplitude modulation signal S2 on high frequency phase modulation signal S4 over a wide range.

[0058] FIG.5 shows the relationship between a supply voltage and an output voltage of nonlinear amplifier 120. As shown in FIG.5, at nonlinear amplifier 120, the square of a supply voltage is proportional to the output voltage. Here, the amount of leakage power is determined by parasitic capacity 121 and the input signal level of nonlinear amplifier 120 (the output signal level of variable gain ~~amplification section~~ amplifier 201).

[0059] Here, in the case of not providing variable gain ~~amplification section~~ amplifier 201, since the output of frequency synthesizer 106 is substantially constant, the leakage power is also constant. In that case, in order to reduce the level of transmission output signal S30, the supply voltage of nonlinear amplifier 120 is reduced, but the reduction is restricted by the leakage power, and the output level cannot be reduced more than a fixed value.

[0060] On the other hand, in this embodiment, by controlling the gain of ~~variable gain~~ amplifier 202 by gain control signal S12 and controlling the level of a high frequency phase modulation signal to be inputted to high frequency power amplifier 105, it is possible to reduce the leakage power. Therefore, at high frequency power amplifier 105, it is possible to extend the output power control range by the supply voltage.

[0061] Furthermore, ~~variable gain~~ amplifier 203 performs amplitude modulation on the output signal of ~~variable gain~~ amplifier 202 based on baseband amplitude modulation signal S2, and thereby the input level of high frequency power amplifier 105 follows instantaneous level fluctuation of baseband amplitude modulation signal S2 and the leakage power is reduced so that it is possible to improve reproducibility of instantaneous level fluctuation. That is, input of high frequency power amplifier 105 can be controlled according to instantaneous output power.

[0064] On the other hand, as for high frequency phase modulation signal S4, when the level of transmission output signal S30 is relatively small, terminal b and terminal c of switch 111 are connected by mode switching signal S10, baseband amplitude modulation signal S2 in which a lower limit value is not limited is inputted to linear-log conversion section 206, amplitude modulation is performed on the output signal of ~~variable gain~~ amplifier 202 at ~~variable gain~~ amplifier 203 based on this baseband amplitude modulation signal S2, and the result is outputted to high frequency power amplifier 105.

[0065] Furthermore, when the level of transmission output signal S30 is relatively small, gain offset signal S20 is set at zero, and gain control signal S21 without an offset is inputted to ~~variable gain~~ amplifier 202. High frequency power amplifier 105 linear-amplifies output of ~~variable gain~~ amplifier 203 under the fixed supply voltage supplied from amplitude modulation signal amplifier 104 and obtains transmission output signal S30.:

[0067] That is, when the level of transmission output signal S30 is relatively large, high frequency power amplifier 105 is used as a nonlinear amplifier, and instantaneous amplitude control based on baseband amplitude modulation signal S2 and average output level control based on gain control signal S12 are performed at the supply voltage applied to high frequency power amplifier 105. When the level of transmission output signal S30 is relatively small, high frequency power amplifier 105 is used as a linear amplifier, and instantaneous amplitude control and average output level control are performed at variable gain ~~amplification section~~ amplifier 201 provided in the anterior stage of high frequency power amplifier 105. By this means, it is possible to control the level of transmission output signal S30 over a wide range.

[0068] Furthermore, when high frequency power amplifier 105 performs nonlinear operation, by controlling a gain of ~~variable gain~~ amplifier 202 according to gain control signal S12 and varying the level of high frequency phase modulation signal S4, it is possible to reduce the leakage power at high frequency power amplifier 105 and consequently extend the output power control range by the supply voltage.

[0069] (Embodiment 2)

A case has been described above with Embodiment 1 where the case has been described where only instantaneous amplitude fluctuation by baseband amplitude modulation signal S2 is provided by ~~variable gain~~ amplifier 203, but with this embodiment, average signal level control in addition to instantaneous amplitude fluctuation control by baseband amplitude modulation signal S2 is performed at ~~variable gain~~ amplifier 203.

:

[0070] FIG.6 shows a configuration example to realize this. In FIG.6, in which the same reference numerals are assigned to the parts corresponding to FIG.2, variable gain ~~amplification section~~ amplifier 210 adds a log-converted baseband amplitude modulation signal and gain control signal 2 at adder 211. By this means, at ~~variable gain~~ amplifier 203, it is possible to provide instantaneous amplitude fluctuation by baseband amplitude modulation signal S2 and average signal level fluctuation by gain control signal 2. Then, average signal level control is assigned to ~~variable gain~~ amplifier 202 and ~~variable gain~~ amplifier 203 so that it is possible to reduce the number of stages of ~~variable gain~~ amplifier 202 and thereby reduce the circuit scale. Furthermore, even in the case where the performance of variable gain amplifiers is limited for a gain control signal, it is possible to perform amplification processing with sufficiently wide dynamic range according to the gain control signal.

[0071] Still further, in FIG.6, average signal level control according to gain control signal 1 is performed at ~~variable gain~~ amplifier 202, but, in some cases, instantaneous amplitude control and average signal level control can be performed by ~~variable gain~~ amplifier 203 alone, and therefore it is possible to further reduce the circuit scale. --

IN THE CLAIMS:

The claims have been amended as follow:

--1(currently amended). A transmission apparatus using a polar modulation scheme, comprising:

an amplitude phase separator that separates baseband modulation data into a baseband amplitude modulation signal and a baseband phase modulation signal;

a phase modulator that modulates a high frequency carrier signal based on the baseband phase modulation signal and forms a high frequency phase modulation signal;

a variable gain amplifier that is provided in a later stage of said phase modulator and amplifies the high frequency phase modulation signal; and

a high frequency power amplifier that is provided in a later stage of said variable gain amplifier and amplifies power of the high frequency phase modulation signal amplified by said variable gain amplifier,

wherein said variable gain amplifier comprises:

a linear-log converter that linear-log converts the baseband amplitude modulation signal; and

an ~~a variable gain~~ amplifier that amplifies the high frequency phase modulation signal based on the linear-log converted baseband amplitude modulation signal and a gain control signal.

2 (currently amended). The transmission apparatus according to claim 1, wherein:

said variable gain amplifier further comprises an adder that adds the baseband amplitude modulation signal linear-log converted by said linear-log converter and the gain control signal; and

said ~~variable gain~~ amplifier amplifies the high frequency phase modulation signal based on the signal added by said adder ~~circuit~~ . --

REASONS FOR ALLOWANCE

2. The following is an examiner's statement of reasons for allowance: a transmission apparatus is disclosed and claimed. The closest prior art applicant's admitted prior art fig. 1 discloses similar apparatus. However, applicant admitted prior art does not teach, in combination with the other claimed limitations, the limitations of" a linear-log converter that linear-log converts the baseband amplitude modulation signal; and a variable gain amplifier that amplifies the high frequency phase modulation signal based on the linear-log converted baseband amplitude modulation signal and a gain control signal".

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jean B. Corrielus whose telephone number is 571-272-3020. The examiner can normally be reached on Monday-Thursday from 9:30-3:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Chieh Fan can be reached on 571-272-3042. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Jean B Corrielus/
Primary Examiner, Art Unit 2611

ABSTRACT OF THE DISCLOSURE

A transmission device having a preferable power efficiency and a wide control range of transmission output power. A pre-stage side of a high-frequency power amplifier changes an amplitude of a high-frequency phase modulation signal according to a base band amplitude modulation signal and a gain control signal. A variable gain amplifier changes the amplitude of the high-frequency phase modulation signal according to the base band amplitude modulation signal and the gain control signal, so that the base band amplitude modulation signal is supplied to ~~a variable gain~~ an amplifier via a linear-log converter.